EPA Feedback	CRC Response
Is there a lower confining zone? If so, please describe it in the permit application narrative.	The 26R reservoir is hydraulically separated by the underlying sands as shown by pressure differential (Figure 9 of the AoR and Corrective Action Plan). The base of the 26R reservoir is mapped and shales beneath the reservoir have a permeability of less than 0.01 mD.
In future updates to the permit application narrative, please label the injection wells on the maps (e.g., on Figure 2) to provide situational context.	Complete
Which wells in Figure 4 contain data from the Reef Ridge Shale? Please elaborate on the characteristics of the Reef Ridge Shale, citing available well-specific data.	All wells in Figure 4 includes data on the Reef Ridge Shale. The data (logs) help define stratigraphy, structure and the lithology. Refer to pages 16 and 18 for additional description of the Reef Ridge Shale. CTV sites data from well 355X-30R.
Was any data collected during the logging and testing performed during drilling of the 373-35R injection well? If so, please characterize this data.	Open hole logs (neutron-density, spontaneous potential, laterolog) were acquired to understand reservoir quality.
Several of the figures in the narrative that contain data are difficult to read (e.g., Figures 14 and 27); please provide higher resolution versions of this information.	Complete
Please provide a map of the Elk Hills Oil Field that shows the 373-35R well, the three proposed new injectors for the Elk Hills 26R storage project, and the 355-7R and 357-7R injection wells for the Elk Hills A1-A2 Project (with a scale that shows distances).	Figure 7 on page 9.
Approximately how far apart will the four injection wells be from each other?	The distance between the four injectors is 6,800, 1,000 and 3,400 feet.
If no pressure build-up test results exist for the 373-35R injection well, perform pressure build-up testing as part of the Pre-Operational Testing Plan.	Request technical discussion prior to inclusion in the preoperational testing plan.
Please update Figure 9 to label the formations in which the thrust faults terminate and the upper and lower extents of these formations.	Complete
The application (e.g., on pg. 10 and 32) refers to the 26R anticline. Is this the same anticline as the 31S anticline? If so, please clarify the application.	Clarified. The anticline is 31S and the reservoir is 26R.
Please elaborate on the findings of the 2019 3D seismic survey described on pg. 10 and the evidence that there are no faults that transect the Monterey Formation or penetrate into the lower Reef Ridge Shale.	The 3D seismic survey was reprocessed in 2019 to allow for enhanced imaging of the reservoirs and structure within the Elk Hills Oil Field. There are no offset seismic reflectors in the Monterey Formation through to the Reef Ridge Shale in the AoR that would indicate faulting.
Where were the 66 oil samples collected within the EHOF described on pg. 12 relative to faults within the field? Is any geochemical data available to support the discussion of geochemical analyses on page 12?	See Figure 2 for sample locations and Zumberge reference for geochemical data.
Collect pressure data in the Etchegoin Formation to support upward confinement between the Monterey Formation and shallower formations.	Refer to Figure 9 of the AoR and CA document.
There is a typo on Figure 15, "Capitally" for Mercury Injection Capillary Pressure. Please fix this when the application is updated.	Corrected.
Please characterize, name, and provide depth and permeability data for the underlying confining unit, if one exists.	The 26R reservoir is hydraulically separated by the underlying sands as shown by pressure differential (Figure 9 of the AoR and Corrective Action Plan). The base of the 26R reservoir is mapped and shales beneath the reservoir have a permeability of less than 0.01 mD.
Please provide evidence to explain why CTV does not consider the Upper Tulare Formation to be a USDW within the modeled AoR of the 26R Project injection wells.	The Upper Tulare is unsaturated in the AoR with no groundwater present. The Lower Tulare aquifer exemption approval was received in March 2018.
It appears that Figure 24 provides information on the depth and regional extent of the area shown in cross section with wireline logs for TDS content, however the resolution is low. Please provide a higher resolution version of Figure 24.	Complete
What is the depth of the Upper Tulare Formation and its separation from the injection zone and the confining zone within the AoR in the vicinity of the 26R project wells?	The average depth of the Upper Tulare in the AoR is 502 feet TVD. The separation between the Upper Tulare and the Reef Ridge is 4,490 and the injection zone is 5,512 feet (page 29).
Is a boring log available for Well 1CH-27R with lithology, water level, or water quality parameters to provide additional information about the Tulare Formation?	The Upper and Lower Tulare are unsaturated. The Lower Tulare is exempt and CRC is disposing water into the zone. There are many wells with open-hole well logs in the 26R area to fully characterize the Tulare. There is no ground-water level for the Tulare within the AoR. For additional information, please the EPA aquifer Phase 1 and Phase 2 exemption application can be referenced.
Several of the references to Figures 24-28 in the section on "Hydrologic and Hydrogeologic Information" (pg. 26-28) are incorrect. Please revise the narrative text.	Updated.
Where is Well 356-26R, the source of hydrocarbon geochemistry in the Monterey Formation, and is any water quality (i.e., TDS) data available from this well? If so, please provide this.	A reference map has been added. TDS data not available.

Please provide any additional Monterey Formation water quality data that was collected as part of the "routine surveillance" described on page 31 to support a more thorough understanding of the formation's water quality throughout the AoR and to support a determination that the Monterey Formation is not a USDW.	Refer to Figure 29 for Monterey Formation TDS.
Is any water quality data available for the Etchegoin Formation? If so, please provide this.	Added to page 33. The Etchegoin Formation water sample is 31,725.4 TDS.
Establish baseline geochemistry for the Monterey Formation in the vicinity of the 26R project wells, as well as the Tulare and Etchegoin Formations for all analytes to be monitored during injection operations, per the Testing and Monitoring Plan.	CTV has provided fluid samples for the Monterey Formation, Etchegoin Formation in the AoR.
Where is the well that is the source of the data in Table 3?	Table 3 has been updated to Table 4. The source of the data for the Monterey Formation pore pressure gradient is from the initial pressure for the Monterey Formation reservoir. Overburden gradients are determined by density log integration. The Monterey Formation fracture gradient is from well 388-26R. The Reef Ridge confining layer fracture gradient and pore pressure will be determined as part of preoperational testing.
Given that well 355X-30R, the source of the Reef Ridge Shale porosity/permeability data, is outside of the AoR, please explain how this data is representative of the confining zone throughout the AoR of the 26R project.	The Reef Ridge is a regional shale. Given the proximity and depositional environment the 355X-30R well is representative of the Reef Ridge in the AoR. Open-hole logs in the field allow for analysis of lithology, these logs also demonstrate continuity.
Please provide Monterey Formation and/or Reef Ridge Shale permeability data from some of the wells depicted on Figure 4 to support a more thorough characterization of the formations throughout the AoR.	Porosity and permeability from MICP is shown in Figure 15.
Please discuss the selection of the base case parameter values (i.e., Young's Modulus, thickness, etc.) in the geomechanical modeling.	A discussion has been added to Page 25 and page 26.
Please update Figure 21 to include the base case pressure.	Added a comment has been added that clarifies the base case.
The application references core data from 13 wells on page 15.	
o To which wells does this refer and where are they located?	Updated Figure to include all wells.
o If they are not distributed throughout the AoR of the 26R project, please describe how they are representative of the entire area that will be affected by injection.	There is one well in the 26R project. The permeability function, that includes the 26R well, demonstrates that the Monterey Formation can be characterized by a function across low and high permeabilities.
Where are the 11 wells that are the source of ductility data discussed on pg. 20 located?	Map included in Figure 19.
Does reference to the "GEOME0.CH" geomechanical model on pg. 21 contain a typo? If so, please correct this.	Complete
Laterally, the wells with MICP core data are concentrated around the northern end of the 31S structure. Is any MICP core data available from wells on the southern end of the 31S anticline?	Figure 16 illustrates one well within the AoR that has MICP core data.
The application states that, "The final/maximum values for surface and downhole injection pressures are far below those associated with the Class II permitted fracture gradients of .8 psi/foot," and that, "the final reservoir pressure target of 3,250 PSI is significantly below the Reef Ridge confining shale estimated minimum geomechanical tensile failure pressure of ~7,500 PSI" (pg. 38). Please clarify the sources of data used to determine failure pressure, fracture pressure, and fracture gradient.	The tensile failure for Reef Ridge is 7,500PSI based on geomechanical modeling. The Reef Ridge Shale confining layer fracture pressure will be addressed in preoperational testing. The Monterey Formation fracture gradient is 0.701 based on a test in 388-26R.
Determine the porosity and permeability of the Reef Ridge Shale at the location of each of the 26R project wells.	Added to Table 3, page 18.
Please provide a map showing the locations of the 9 wells used as the source for XRD and the well that was the source for Fourier Transform Infrared Spectroscopy described on page 14.	Locations shown on Figure 14.
What evidence is there for depositional continuity and facies consistency within the EHOF, as described on page 14?	Discussion added to Page 14.
Please include all earthquakes of magnitude 3.0 and above in Figure 22.	Complete
The text on pg. 24 of the narrative refers to historical earthquake data in Figure 23; however this information is presented in Figure 22. Similarly, the text in point 2 on pg. 25 refers to the VS30 analysis of Figure 23 but references Figure 24. Please revise the text accordingly.	Updated
To inform an evaluation and documentation that there is no significant seismic risk associated with the Class VI project, please describe how the project:	
o has a geologic system free of known faults and fractures and capable of receiving and containing the volumes of CO2 proposed to be injected.	Added, refer to pages 28 - 30.
o will be operated and monitored in a manner that will limit risk of endangerment to USDWs, including risks associated with induced seismic events;	Added, refer to pages 28 - 30.
o will be operated and monitored in a way that, in the unlikely event of an induced event, risks will be quickly addressed and mitigated; and	Added, refer to pages 28 - 30.
o poses a low risk of inducing a felt seismic event.	Added, refer to pages 28 - 30.
Establish baseline seismicity after the shallow borehole and surface seismometers (which are described in Attachment C) are installed.	This will be addressed as part of the project preoperational testing.

Please clarify what data sources were used to determine inputs for the geo-cellular model where applicable, e.g., the inputs for sand vs. shale reservoir facies as discussed on pg. 32.	Discussion added to Page 14.
Please elaborate on how any well log data (e.g., from the wells shown on Figures 5 and 6) contributes to an understanding of the homogeneity of facies within the injection and confining zones.	Discussion added to Page 14.
Please also discuss how a sufficient number and distribution of formation characterization data are available to demonstrate a lack of local heterogeneities that could affect CO2 storage or confinement.	Discussion added to Page 14.
Please clarify which wells are depicted on cross sections (e.g., Figures 5, 6, and 24), and if available, augment the narrative discussion with relevant log-derived evidence about the site.	Image quality improved to ensure that well names are legible.
Please specify the names, number, and locations of wells that were used to characterize formation thicknesses for the maps in Figure 12.	Discussion added to Page 14.
Determine if there are any heterogeneities within the Monterey 26R Reservoir that could affect its suitability for injection, including facies changes that could facilitate preferential flow.	Discussion added to Page 14.
Please provide evidence for the statement on page 31 of the narrative that the quartz and feldspar in the Monterey Formation are stable in the presence of CO2 and carbonic acid.	This will be addressed as part of the project preoperational testing.
Please elaborate on why use of the Peng-Robinson Equation of State supports compatibility of the CO2 with any fluid that may be contained within the Reef Ridge Shale.	Due to the extremely low permeability of the Reef Ridge Shale (< 0.01mD) and the high capillary entry pressure (4,220psi), the Peng Robinson Equation of State based simulation is valid to model the project over the expected reservoir pressure range of 250 – 4,000psi as there should be no entry of the CO2 injectate into the Reef Ridge
The reference to the hydrocarbon analysis for Well 356-26R at the bottom of pg. 30 should refer to Figure 29, not Figure 30. Please revise the narrative.	Updated.
Confirm the composition and water content of the CO2 injectate as part of baseline sampling and provide verification (e.g., via benchtop studies or laboratory analyses) that it will not react with the formation matrix.	This will be addressed as part of the project preoperational testing.
Does any pressure data exist to provide evidence of pressure differentials that would demonstrate confinement between the Monterey 26R Formation and shallower formations? If none exists, please include characterizing the pressure in the Etchegoin Formation in the pre-operational testing plan.	Figure 10 of the AoR and Corrective Action Plan demonstrates the pressure isolation between the 26R reservoir and the overlying Etchegoin Formation and underlying Lower Monterey Formation reservoirs.
Please provide specific geochemical data that support the statement on pg. 11 of the narrative that, "Geochemical analysis of reservoirs within the EHOF also confirms compartmentalization through several million years and	Refer to the Zumberge reference for the supporting geochemical data.
Test for changes in capillary entry pressure of the Reef Ridge Shale due to reaction of the shale with the injectate via laboratory experiments.	This will be addressed as part of the project preoperational testing.
A step rate test should be performed to establish the fracture pressure of the confining zone.	This will be addressed as part of the project preoperational testing.